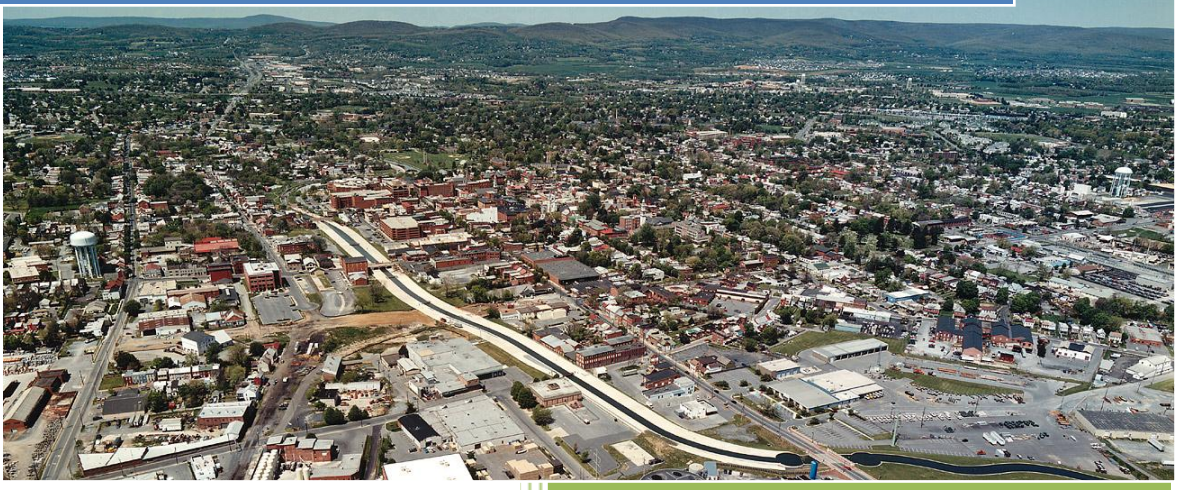
Frederick County Greenhouse Gas Emissions Inventory Report

Community and Government Operations

2007 BASELINE



Prepared for the Board of County Commissioners

May 2011 Amendment

Greenhouse Gas Emissions Inventory Report

May 2011 Amendment

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This report is intended to supersede the report dated August 2010. Greenhouse gas emissions calculations have changed significantly as a result of data from Allegheny Power for 2007 electricity consumption. In addition, modifications in accounting software were made to account for updated emissions factors as published in the Emissions & Generation Resource Integrated Database (eGRID) by the Environmental Protection Agency.

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Project Background and Overview

In 2009, the Office of Sustainability & Environmental Resources (OSER), formerly known as the Office of Environmental Sustainability, obtained funding from the U.S. Department of Energy's (DOE) Energy Efficiency and Conservation Block Grant (EECBG) program to conduct a greenhouse gas emissions inventory as a component of a broader climate, energy and green building initiative. OSER was directed by the Board of County Commissioners (Board) to forward an Energy Efficiency and Conservation Strategy to DOE, which served as a guide for program implementation. The strategy is comprised of the following goals and objectives for the EECBG-funded initiatives:

GOALS

- Implement the County's Comprehensive Energy Plan, which establishes annual, definitive goals to reduce the use of non-renewable energy in county buildings, facilities, and vehicle fleet by 50% or more by 2024.
- Make measurable reductions in greenhouse gas emissions through improvements to buildings and facilities, (residential, commercial, and institutional/governmental) which are known to be the largest single source in the U.S.
- Increase consumer awareness and adoption of energy efficiency, conservation and renewable energy measures.

OBJECTIVES

- Conduct a county-wide inventory of greenhouse gas and air pollution emissions.
- Initiate a comprehensive, countywide program to increase energy efficiency and reduce overall energy consumption and costs associated with building performance.
- Increase deployment of renewable/alternative energy throughout the county.

The availability of funding through the EECBG program provided momentum to the Board's sustainability initiatives already in progress. In 2007, the Board endorsed the U.S. Mayor's Climate Protection Agreement by Resolution 07-14 and adopted a strategic plan that incorporated numerous sustainability-related goals. In 2008, they established the Office of Sustainability & Environmental Resources to coordinate climate, energy and environmental programs and the next year, appointed 13 citizens to the Frederick County Sustainability Commission. An internal Sustainable Action Team was also organized in 2009 to integrate sustainable practices into county operations.

This publication provides a report of the estimated anthropogenic sources of greenhouse gas emissions attributed to Frederick County Government facilities and operations, as well as the community at large for the baseline year of 2007. A comprehensive GHG inventory and accompanying inventory maintenance system have been developed for Frederick County. This inventory was conducted using a comprehensive and detailed methodology for estimating sources of greenhouse gases. The inventory provides Frederick County with a baseline for comparing future

performance and tracking progress of energy conservation initiatives and emission reduction strategies.

Greenhouse Gas Inventory Background

A greenhouse gas inventory is an accounting of greenhouse gas (GHG) emitted to or removed from the atmosphere over a period of time, most typically a one calendar year period. The first GHG inventory of an entity becomes the baseline inventory against which future inventories and forecasts will be compared. Developing a baseline emissions inventory for county government operations (buildings, facilities, vehicle fleet, solid waste, refrigerants and indirect sources) and the community as a whole (residential, commercial and industrial, transportation, waste and other) is a critical step in understanding the county's use of fossil fuels, electricity, and waste disposal. Data from the baseline inventory may guide policy decisions, prioritization of capital improvement projects, and implementation of the County's Comprehensive Energy Plan's energy reduction strategies.

Benefits of Developing a GHG Inventory

The benefits of developing a GHG inventory include:

- **Risk Management**. Voluntarily reporting GHG emissions will help Frederick County manage climate risk by documenting early actions to reduce GHG emissions. Such information may be accepted by future state, federal or international regulatory GHG programs.
- **Addressing Inefficiencies**. Accounting for emissions can help Frederick County gain better insight into the relationship between improving efficiency (reducing energy and waste) and reducing emissions -- and ultimately save money and resources.
- **Readiness for a Carbon Constrained Future**. Identifying emissions sources to develop a GHG inventory will prepare Frederick County to respond to the potential impact of new regulations.
- **Recognition as an Environmental Leader**. Voluntarily reporting GHG emissions positions Frederick County with a pathway to recognize, publicize, and promote their environmental stewardship.
- **Stakeholder Education**. Assembling an annual GHG emissions inventory can help inform management, constituents, employees and the public about the County's GHG emissions profile.

Adapted from the Local Government Operations Protocol Version 1.0

Climate Change Background

Climate change has become one of the defining issues of the 21st century. The potential disruption of our global climate system renders any continuing future as a fossil fuel based economy impossible.

> *"Climate change is occurring, is caused largely by human activities, and poses significant risk for – and in many cases is already affecting – a broad range of human and natural systems."*
>
> *Intergovernmental Panel on Climate Change, Fourth Assessment Report, Working Group I*

Atmospheric greenhouse gases (GHGs) and clouds within the Earth's atmosphere influence the Earth's temperature by absorbing most of the infrared radiation rising from the Earth's sun-warmed surface that would otherwise escape into space, a process known as the "greenhouse effect". The resulting balance between incoming solar radiation and outgoing radiation from both the Earth's surface and atmosphere keeps the planet habitable. Current life on Earth could not be sustained without the natural greenhouse effect.

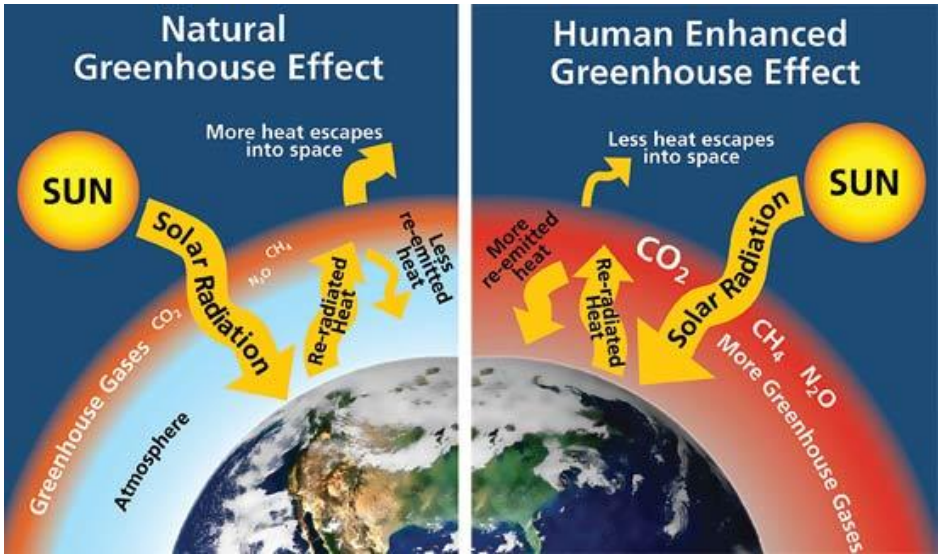


Figure 1: Comparison of the Natural versus Human Enhanced Greenhouse Effect
Source: http://www.nps.gov/goga/naturescience/images/Greenhouse-effect.jpg

But the greenhouse effect is becoming stronger as a result of human activities, primarily through the burning of fossil fuels for transportation and electricity generation, and the deforesting of large areas of land. The IPCC attributes humanity's global warming influence primarily to the increase of three key heat-trapping gases in the atmosphere: carbon dioxide, methane, and nitrous oxide. Human-produced emissions of these GHGs into the atmosphere enhance the greenhouse effect by absorbing additional radiation that would otherwise escape into space. This traps more heat in the atmosphere, causing temperatures to rise. This rise in global average temperatures is

referred to as global warming. According to the IPCC, “most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations”. Under IPCC guidance, the determination of "very likely" represents greater than 90% likelihood.

This enhanced greenhouse effect that causes increasing average *global* surface temperatures in turn affects climate patterns worldwide. Sometimes the concepts of global warming and climate change are used interchangeably, and while they are related, they are not the same. Because of this increase in global surface temperature, climate change is occurring and can be seen in extreme weather, rising sea levels and climate-related natural disasters. It exists because of human activities, anthropogenic causes, which have altered the composition of the Earth's atmosphere, changing the physical face of the Earth and the pattern of our everyday lives.

Many of the impacts of a changing climate will be felt on a local level. Cities and local governments will be directly confronted with the challenges of extreme weather, rising sea levels, and climate-related natural disasters. The *National Capital Region's Climate Change Report* produced by the Metropolitan Washington Council of Governments (MWCOG) ranked the risk level for severe weather events for Maryland's jurisdictions, and reported Frederick County as follows:

- High Risk
  - Drought
  - Flash/River Flooding
  - Thunderstorm
  - Tornado

- Medium Risk
  - Extreme Heat
  - Winter Weather (Snow and Ice)

These severe weather events could directly impact Frederick County's hydrology and water resources, agriculture, biodiversity, forests, recreation, energy, transportation, and human health and welfare, and therefore were included in the *Frederick County Hazard Mitigation Plan* as adopted by the Board of County Commissioners in June of 2010, and analyzed and prioritized accordingly.

Regional Context

Maryland’s Commission on Climate Change, established by Executive Order in 2007, concludes that our State would see significant benefit, both economic and environmental, from taking early, immediate actions to reduce global warming pollution. The commission’s 2008 *Climate Action Plan* established a greenhouse gas and carbon footprint reduction strategy for Maryland and paved the way for Governor O’Malley’s

Smart, Green and Growing legislative package. This package included the Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) which commits Maryland to:

- Reduce GHG emissions 25% by 2020; and
- Prepare a plan to meet a longer-term goal of reducing emissions up to 90% by 2050.

On November 12, 2008, MWCOG issued their National Capital Region Climate Change Report which estimates that based on current business as usual (BAU) population growth projections for the region, greenhouse gas emissions will increase 35-38% by 2030 and 43-47% by 2050. In response to these projections, the report sets forth emissions goals for three target years, calling for reductions of:

- 10% below BAU levels by 2012;
- 20% below 2005 levels by 2020; and
- 80% below 2005 levels by 2050

The report stresses the urgency of early action to avert the worst predicted impacts of climate change and provides a regional framework to transition to a low-carbon future today.

Reasoning, Methodology & Model

Greenhouse gas emissions inventories are rarely, if ever, based on direct measurement of emissions. Instead, emissions are estimated based on accepted models and methodologies with the greatest degree of accuracy as possible.

Accounting and Reporting Principles

The Frederick County GHG emissions inventory was conducted in accordance with the principles of the Local Government Operations Protocol (LGOP). The LGOP is the collaborative effort of ICLEI, the California Air Resources Board, the California Climate Action Registry, and The Climate Registry to provide a standardized set of guidelines to assist local governments in quantifying and reporting GHG emissions associated with their government operations. The LGOP is now the official standard for all local governments in the United States who wish to prepare and report GHG emissions associated with their government operations. By following the protocol, Frederick County's energy and emissions efforts will be compatible with programs by the collaborating partners, and with other regional entities that adopt the LGOP for their programs. The key principles set forth in the LGOP are:

- **Relevance**: The greenhouse gas inventory should appropriately reflect the greenhouse gas emissions of the local government and should be organized to

reflect the areas over which local governments exert control and hold responsibility in order to serve the decision making needs of users.

- **Completeness**: All greenhouse gas emission sources and emissions-causing activities within the chosen inventory boundary should be accounted for. Any specific exclusion should be justified and disclosed.
- **Consistency**: Consistent methodologies should be used in the identification of boundaries, analysis of data and quantification of emissions to enable meaningful trend analysis over time, demonstration of reductions, and comparison of emissions. Any changes to the data, inventory boundary, methods, or any relevant factors in subsequent inventories should be disclosed.
- **Transparency**: All relevant issues should be addressed and documented in a factual and coherent manner to provide a trail for future review and replication. All relevant data sources and assumptions should be disclosed, along with specific descriptions of methodologies and data sources used.
- **Accuracy**: The quantification of greenhouse gas emissions should not be systematically over or under the actual emissions. Accuracy should be sufficient to enable users to make decisions with reasonable assurance as to the integrity of the report information.

-Local Government Operations Protocol, 2009

A community-wide GHG inventory protocol similar to the LGOP is currently in development by ICLEI-Local Governments for Sustainability and its partners. The 2011 launch of the community protocol coupled with more comprehensive community data available from MWCOG and Allegheny Power will further develop and refine our community emissions component.

CACP Software

ICLEI, in collaboration with the National Association of Clean Air Agencies (NACAA) developed the 2009 version of the Clean Air and Climate Protection Software (CACP 2009) which supports emissions inventories based on the LGOP's principles and guidelines. CACP 2009 is an emissions management tool that calculates and tracks emissions associated with electricity, fuel use, waste disposal and other processes. CACP 2009 also acts as a place to record and store emissions data from other sources that was calculated outside the software.

The CACP tool reports the emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), as well as hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6), and perfluorocarbons (PFCs). These six gases are the internationally recognized greenhouse gases regulated under the Kyoto Protocol of 1997. In addition, CACP reports levels of certain criteria air pollutants (particulate matter) identified by the U.S. Environmental Protection Agency (EPA) as posing significant health threats.

CACP 2009 calculates emissions by applying specific factors (or coefficients) of a particular pollutant (e.g., carbon dioxide) according to fuel type to activity data for the applicable sector. The basic equation is:

Activity Data x Emission Factor = Emissions

Calculating carbon dioxide (CO_2) emissions is relatively straightforward as emissions are determined directly by the amount of fuel or energy used. However, other greenhouse gases such as nitrous oxide (N_2O) and methane (CH_4) are aggregated and reported as metric tons of carbon dioxide equivalents ($mtCO_2e$), a commonly used unit that combines greenhouse gases of differing impact on the earth's climate into one weighted unit. This differing impact is referred to as the global warming potential (GWP). Table 1 lists the GWP of greenhouse gases reported in this inventory.

Table 1: Global Warming Potential (GWP) and Sources of Reported Greenhouse Gases

Greenhouse Gas	GWP	Sources
Carbon Dioxide (CO_2)	1	Fossil fuel combustion, forest clearing, cement production, etc.
Methane (CH_4)	21	Landfills, production and distribution of natural gas & petroleum, fermentation from the digestive system of livestock, rice cultivation, fossil fuel combustion, etc.
Nitrous Oxide (N_2O)	310	Fossil fuel combustion, fertilizers, nylon production, manure, etc.
Hydrofluorocarbons (HFCs)	140-11,700	Refrigeration gases, aluminum smelting, semiconductor manufacturing, etc.
Perfluorocarbons (PFCs)	6,500 – 9,200	Aluminum production, semiconductor industry, etc.
Sulfur Hexafluoride (SF6)	23,900	Electrical transmissions and distribution systems, circuit breakers, magnesium production, etc.

Source: IPCC, Second Assessment Report,

For example, the emission of 1 ton of methane (CH_4) has the global warming potential (GWP) 21 times that of CO_2. To calculate carbon dioxide equivalents ($mtCO_2e$), the actual amount of the greenhouse gas emission is multiplied by its GWP. To avoid confusion between emissions of the different gases with their respective GWPs, all emissions in this report are reduced to the common unit of "metric tons of carbon dioxide equivalent" ($mtCO_2e$). One metric ton is equal in mass to 2,204.62 pounds.

Inventory Boundaries

This report provides the comprehensive greenhouse gas (GHG) emissions inventory for emissions from sources within Frederick County's geopolitical boundaries. For the emissions attributable to Frederick County government, a subset of the community

inventory, this report uses the guiding principle of operational control. Operational control is defined as any facility or operation for which the county has the full authority to introduce and implement changes in operational policies and processes. Accordingly, the Frederick County government portion of the GHG inventory reports emissions categorized within the following sectors with a reference to the responsible division:

- Buildings and other facilities (e.g. satellite or tower site) – *Management Services*;
- Water delivery, water treatment and solid waste facilities – *Utilities and Solid Waste Management;*
- Streetlights and traffic signals – *Management Services*;
- Vehicle fleet – *Management Services*;
- Transit fleet – *Transit Services*; and
- Landfill process emissions – *Utilities and Solid Waste Management*.

Although not meeting the operational control definition and also considered an "optional" item under the LGOP, this GHG inventory does report the greenhouse gas emissions associated with the travel of its employees to and from work in personal vehicles. This item is included because Frederick County government has the opportunity to influence these emissions by initiating programs and creating incentives that promote transportation alternatives.

Baseline Selection

The inventory guidelines of the LGOP direct the use of a complete calendar year as a baseline. Setting a baseline establishes a benchmark from which to compare progress going forward and thus should be a calendar year for which complete and accurate data is available, a year that is representative (avoid anomalies in data with regard to emissions, weather or other events, or drastic changes in processes or procedures) and a year that is in line with the baseline years used in inventories of other regional entities.

The calendar year 2007 was selected as the baseline year for Frederick County's inventory for the following reasons:

- It is consistent with the 2007 baseline year of the proposed Frederick County Comprehensive Energy Plan.
- We were able to take advantage of extensive data that had been previously collected and aggregated for the 2007 baseline of the Comprehensive Energy Plan resulting in a savings of duplicative staff effort.
- The year 2007 is prior to the implementation of extensive energy conservation and emission reduction strategies. Future GHG inventories can track the results of these strategies.
- The initial year of the term of the current Board of County Commissioners was 2007.
- The year 2007 is reasonably reflective of the baseline year for the inventories of other regional jurisdictions, such as the State of Maryland (2006), Carroll and

Howard Counties and Baltimore City, Maryland (2007), Baltimore County, Maryland (2006), and Arlington and Loudoun Counties, Virginia (2007).

Direct and Indirect Scopes of Emissions

Greenhouse gas emissions are categorized as either direct or indirect. Direct GHG emissions are emissions from sources within Frederick County's geopolitical boundaries, and for the government operations, are from sources within the organizational boundaries that the County owns or controls, as defined in the earlier section on Inventory Boundaries. Indirect GHG emissions are emissions related to activities that take place within the County's boundaries but that are created at sources owned or controlled by another entity.

Under the LGOP and to facilitate reporting, direct and indirect greenhouse gas emissions are categorized into Scopes as follows:

- Scope 1: Direct emissions from stationary and mobile fuel consumption as well as process and fugitive emissions (e.g. from wastewater treatment or solid waste landfill management);
- Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity; and
- Scope 3: Any other indirect emissions not covered in Scope 2 such as outsourced activities, extraction and production of purchased materials, waste disposal, and transport-related activities in vehicles not owned or controlled by the reporting entity, for example, the work commutes of an entity's employees.

Emissions Inventory Results

This inventory report includes the emissions for the community as a whole, as well as those attributable to Frederick County government, a subset of the community emissions. The community is defined as the Frederick County geopolitical boundary that encompasses 663 square miles. In 2007, the county's population was comprised of 231,948 people. The results of the inventory are organized by Community GHG Emissions and Frederick County Government Emissions.

Community Emissions, 2007 Baseline

The community GHG emissions inventory is organized by three major emission sources: energy consumption, mobile combustion (transportation) and waste disposal. Energy use of the residential and non-residential (commercial and industrial) sectors as a result of fossil fuel combustion (natural gas, fuel oil/kerosene, and propane) and

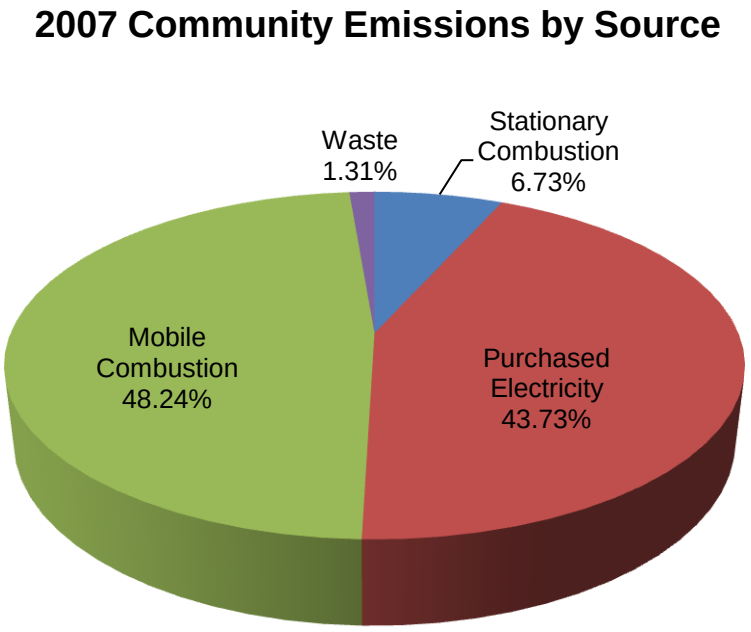
purchased electricity use is included. To account for emissions from mobile combustion, an estimated total of vehicle miles traveled through and within the County from on-road vehicles was disaggregated by vehicle type and fuels used. Waste disposal was factored by disposal method and composition.

The 2007 community-based emissions for Frederick County were 5,041,357 metric tons of carbon dioxide equivalents. The largest source of emissions is attributable to community mobile fossil fuel combustion at 2.43 million metric tons of CO_2e, 48.24% of the total. The second most significant source of emissions is from the community's use of purchased electricity at 2.2 million metric tons, 43.73% of the total.

Table 2: 2007 Community Direct and Indirect Emissions by Source with Percent of Total

Source	Greenhouse Gas Emissions ($mtCO_2e$)	Percent of Total
Direct Emissions		
Mobile Combustion	2,431,798	48.24%
Stationary Combustion	339,042	6.73%
Indirect Emissions		
Purchased Electricity Use	2,204,621	43.73%
Waste	65,896	1.31%
TOTAL Emissions	5,041,357	**100%**

Figure 1 presents 2007 Frederick County community greenhouse gas emissions by source:

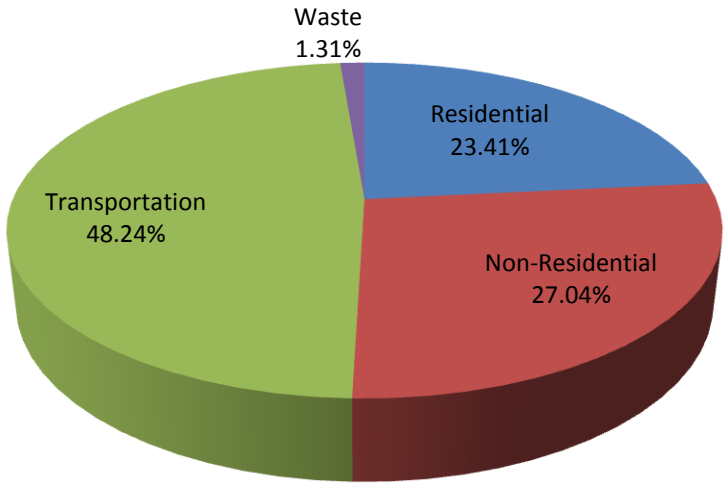


A review of the distribution of the 2007 emissions among sectors of the Frederick County community shows that the transportation sector accounts for nearly half of the total greenhouse gas emissions. The non-residential sector contributes slightly more emissions than the residential sector; together the built environment accounts for about half of the county's overall community emissions.

Table 3: 2007 Community GHG Emissions with Percent of Total by Sector

Sector	GHG Emissions ($mtCO_2e$)	Percent of Total
Residential	1,180,407	23.41%
Non-Residential	1,363,255	27.04%
Transportation	2,431,798	48.24%
Waste	65,896	1.31%
TOTAL	**5,041.356**	**100.00%**

Figure 2: 2007 Community Emissions by Sector



Community Energy Usage

The emissions associated with the community's residential and non-residential sectors were measured in terms of energy consumption. Direct emissions from stationary combustion include natural gas, fuel oil and kerosene, and liquid propane gas. Indirect emissions result from purchased electricity. Table 4 below outlines the various proportions of energy consumption for the community sector.

Table 4: 2007 Community Residential and Non-Residential Fuel Consumption from Direct Stationary Combustion and Indirect Purchased Electricity Use

Fuel Type by Sector	Energy Consumption	Equivalent Energy Consumption in mmBtu	Emissions (mt CO_2e)
Residential			
Natural Gas (therms)	18,635,690	1,863,569	99,134
Fuel Oil & Kerosene (gal)	7,024,613	974,142	71,665
Liquid Propane Gas (gal)	1,418,751	129,160	8,200
Electricity (MWh)	1,413,748	4,825,078	1,001,408
Residential Total		**7,791,949**	**1,180,407**
Non-residential			
Natural Gas (therms)	25,235,786	2,523,579	134,244
Fuel Oil & Kerosene (gal)	2,528,772	350,679	25,798
Liquid Propane Gas (gal)	--	--	--
Electricity (MWh)	1,698,647	5,797,431	1,203,212
Non-residential Total		**8,671688**	**1,363,255**

Community Transportation

In 2007 the estimated emissions attributable to vehicular travel through and within Frederick County were 2,431,798 metric tons of CO_2e, representing almost half of the total community emissions. Frederick County is situated within an hour of two major metropolitan areas, Washington, DC and Baltimore, MD, and is intersected by 5 major highways, clearly a contributing factor to the significant amount of vehicular travel in the County.

The 2007 estimated transportation emissions were derived from traffic modeling reports from the Metropolitan Washington Council of Governments as follows: 2007 Household Travel Survey; 2009 Constrained Long Range Plan (CLRP), and the Fiscal

Year 2010-2015 Transportation Improvement Plan (TIP). Data was available for 2005 vehicles miles traveled (VMT) within and through Frederick County and the 2010 projected VMT. Assuming a linear relationship from 2005 to 2010, vehicle miles traveled were then estimated for 2007.

Table 5: Annual Vehicle Miles Traveled (VMT) in millions for Frederick County

Year	Total	Freeway	Major Artery	Minor Artery	Collectors	Parkways	Ramps	Local
2005	3,545.318	1,743.027	563.898	592.927	133.284	241.600	16.097	254.485
2010 projected	3,855.667	1,870.755	610.332	647.122	156.296	277.993	16.399	276.771
2007 estimated	**3,669.458**							

MWCOG provided data as to the proportion of VMT attributable to different vehicle classes by fuel type for Frederick County vehicles using the 28 vehicle classes within the EPA Mobile 6.2 transportation modeling software. The sub-classes were then summed and aggregated as follows:

Table 6: Proportion of Vehicles by Class for Frederick County

Vehicle Classes	2005	2010 Projected	2007 Estimated
Gasoline			
Passenger (includes Motorcycles)	42.28%	36.47%	39.95%
Light Duty Trucks	49.07%	55.01%	51.44%
Heavy Duty Trucks (includes buses)	2.43%	2.14%	2.32%
Diesel			
Passenger (includes Motorcycles)	.10%	.10%	.10%
Light Duty Trucks	.51%	.07%	.34%
Heavy Duty Trucks (includes buses)	5.61%	6.21%	5.85%
Total	100%	100%	100%

As no data was available that estimated the proportion of VMT within a vehicle class to the level of model year, all vehicles were entered into CACP software as “alternate method vehicles” according to the protocol guidelines. This method applies an average fuel efficiency number for comparable vehicles within a class that are on the road in 2007, rather than a specific average efficiency for a particular model year. From the VMT and average fuel efficiencies, an estimate as to fuel energy consumption for each fuel type was calculated as show in Table 7:

Table 7: Average Fuel Efficiency by Aggregated Vehicle Class and Fuel Type with Energy Consumption

Vehicle Classes	Average Fuel Efficiency (MPG)	Energy Consumption (mmBtu)
Gasoline		**28,691,443**
Passenger (includes Motorcycles)	18.965	
Light Duty Trucks	13.866	
Heavy Duty Trucks (includes buses)	4.855	
Diesel		**4,840,068**
Passenger (includes Motorcycles)	19.378	
Light Duty Trucks	16.934	
Heavy Duty Trucks (includes buses)	5.644	
Total		**33,531,511**

Community Waste

The estimated emissions associated with Frederick County's 2007 waste were 65,896 metric tons of CO_2e, representing 1.3% of the community's total emissions. The majority of the 2007 waste for Frederick County was exported out-of-county. Although the emissions from the waste at out-of-county landfills were beyond the geopolitical boundaries of Frederick County, guiding principle dictates that an entity assume responsibility for the emissions generated by the disposal of its waste. During 2007 the DUWSM managed 232,587.32 tons of municipal solid waste. Of that amount, 28,267.63 tons were placed in the county's Reich's Ford Landfill Site B and the remaining 204,319.69 tons were exported out of the county to the locations as listed in Table 8.

Table 8. 2007 Tonnage Report to Maryland Department of Energy Solid Waste Tonnage for Frederick County Waste Exported

Location	Waste Exported (tons)
Fairfax, Virginia	69,298.38
King George, Virginia	31,669.45
Amelia, Virginia	71.37
Alleghany, Maryland	22,051.06
Franklin, Pennsylvania	81,229.43
Total Waste Exported	**204,319.69**

With only the geographic location of the out-of-county landfills that received the 2007 waste for Frederick County, emissions were estimated based on waste at an average "managed" landfill using the default emissions factors in CACP. This may result in an

over or under-stating of emissions associated with the long-haul transport and disposition of Frederick County's waste.

The specific waste composition data for 2007 Frederick County waste was not available. The waste proportions for this report were derived from a 2005 Montgomery County, Maryland waste composition study, which the DUSWM provided as reasonably reflective of Frederick County's own waste composition for 2007. These proportion percentages were used in this inventory as follows:

Paper	40%
Organic (food)	29%
Yard Waste	1%
Wood	6%
Other (plastic, metals, glass, inorganic)	24%

This report does not attribute the waste to originating sector (e.g. residential, non-residential, government) due to the unavailability of data. Fugitive emissions associated with the long-term management of the historic waste at the County landfill are accounted for within the government operations section of this inventory report.

Community Emissions Summary

To summarize, the 2007 total community-based emissions for Frederick County are 5,041,356 metric tons of CO_2e. This is roughly equivalent to 21.7 metric tons per capita and is just slightly above the national average of about 20 metric tons per capita.

Frederick County Government Operations Emissions, Baseline 2007

The government operations portion of the inventory is organized by four major emission sources: energy consumption, mobile combustion, processes that generate fugitive emissions, and employee commute. Energy consumption includes stationary combustion of fossil fuels (natural gas and fuel oil) and purchased electricity at the County's buildings and facilities. Mobile combustion accounts for the fuel consumed in the operation of the County's on and off-road fleet and transit vehicles. The two processes reported that generate fugitive emissions are associated with the county landfill and wastewater treatment. Subsequent inventories could expand the reported emissions to include other indirect sources such as contract services, supply chain sources, and employee business travel.

In 2007, Frederick County government (FCG) operations emitted a total of 134,667 metric tons of CO_2e. The greatest source of emissions for FCG was fugitive process emissions from the county landfills at the Reich's Ford Facility managed by DUWSM at 86,514 metric tons of CO_2e. The next greatest source of emissions is attributable to purchased electricity for the County's buildings and facilities at 27,846 metric tons of CO_2e, followed by mobile fuel combustion for the County's vehicle and transit fleets at 8,738 metric tons of CO_2e. Figure 3, below, and Table 9 on the following page summarize emissions by source.

Figure 3: 2007 Government Operations Emissions by Source

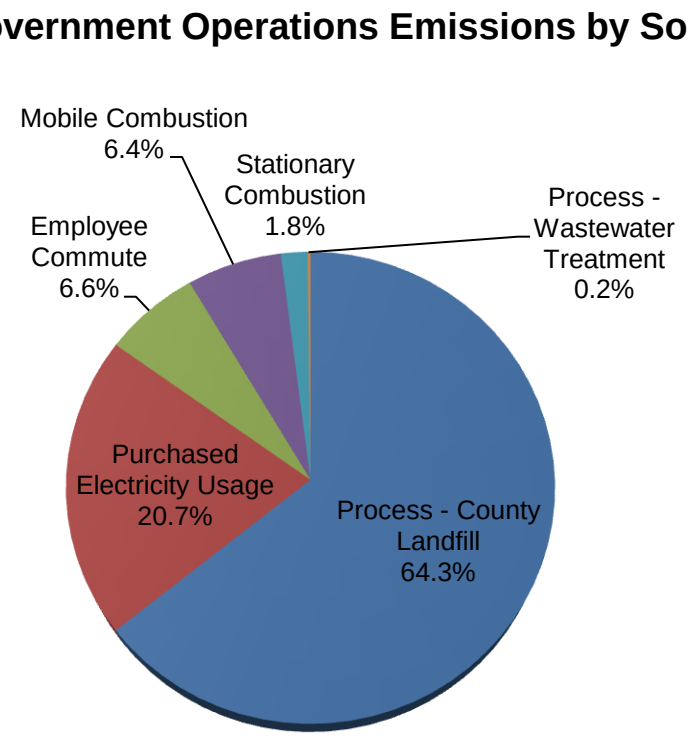


Table 9: 2007 Government Operations Direct and Indirect Emissions by Source and Percent of Total

Source	Greenhouse Gas Emissions ($mtCO_2e$)	Percent of Total
Direct Emissions		
Mobile Combustion	8,738	6.4%
Stationary Combustion	2,453	1.8%
Process - County Landfill	86,514	64.3%
Process - Wastewater Treatment	255	.2%
Indirect Emissions		
Purchased Electricity Usage	27,846	20.7%
Other Indirect Emissions		
Employee Commute	8,861	6.6%
TOTAL Emissions	**134,667**	**100%**

Table 10 summarizes government operations emissions by sector.

Table 10: 2007 Government Operations Emissions by Sector and Percent of Total

Sector	Emissions ($mtCO_2e$)	Percent of Total
Buildings & Facilities	17,893	13.3%
Streetlights & Traffic Signals	344	0.3%
Water Delivery Facilities	4,208	3.1%
Wastewater Facilities	7,004	5.2%
Solid Waste Facilities	850	.6%
Vehicle Fleet	6,492	4.8%
Transit Fleet	2,245	1.7%
County Landfill Process Emissions	86,514	64.3%
Wastewater Treatment Process Emissions	255	.2%
Employee Commute	8,861	6.6%
Total	**134,667**	**100%**

Government Operations Energy Usage

The 2007 annual consumption data for more than 60 buildings and facilities with a combined floor space in excess of 1.2 million square feet; for nearly 50 streetlights and traffic signal locations; and for the County Division of Utilities and Solid Waste Management's facilities was collected and entered into the CACP calculator. The

source of the data for fossil fuel combustion and purchased electricity for the various sectors of Frederick County government was provided by:

- the Division of Utilities and Solid Waste Management for the water delivery, wastewater treatment and solid waste facilities; and
- Management Services Division for all other buildings and facilities, as well as streetlights and traffic signals.

The energy consumption at the DUSWM Operations Center, Greenhouse and Administration Building were combined in the Buildings & Facilities sector as the data records provided reflected a question as to how to categorize those locations. Also, adjustments were made for any data record that did not meet the operational control test. For example, certain state maintained streetlights and/or traffic signals did not meet the operational control test and were not included. Table 11 summarizes the fuel consumption for Frederick County government buildings and facilities:

Table 11: 2007 Government Operations Fuel Consumption from Stationary Combustion and Purchased Electricity Use by Building/Facility Source and Fuel Type

Sector	Natural Gas (therms)	Fuel Oil (gal)	Electricity (MWh)	Total Converted to mmBtu
Buildings & Facilities	417,409	3,747.54	22,291.66	118,342
Streetlights & Traffic Signals	--	--	490.75	1,675
Water Delivery Facilities	49	--	6,000.08	20,483
Wastewater Facilities	36,582	--	9,708.39	36,793
Solid Waste Facilities	-	--	1,211.58	4,135
Total	**454,040**	**3,747.54**	**39,702.46**	**181,428**

Emissions were calculated using the appropriate emissions factor for each fuel type and greenhouse gas. For natural gas and fuel oil/kerosene, this report applies the default emissions factors as set forth in Tables G1 and G3 of the LGOP. The emissions factors for electricity were obtained from the Allegheny Emissions Disclosure Annual Report for calendar year 2007 as submitted by Allegheny Power to the Maryland Public Service Commission.

Table 12: CO_2, CH_4, and N_2O Emission Factors by Fuel Type

Fuel Type	Units	CO_2	CH_4	N_2O
Natural Gas	kg/mmBtu	53.06	5.00×10^{-3}	1×10^{-4}
Fuel Oil / Kerosene	kg/gal	10.15	1.53×10^{-3}	8.33×10^{-5}
Electricity	kg/kwh	.6975	8×10^{-6}	1.2×10^{-5}

The equation for calculating CO_2, CH_4 and N_2O emissions from fuel consumption and purchased electricity is:

Fuel emissions (mt) = Fuel Consumed (units) x GHG Emissions Factor (kg-CO_2/unit) ÷1,000 (kg/mt)

Table 13 sets forth the emissions of the government sectors as a result of energy consumption by that sector.

Table 13: 2007 Government Operations Emissions from Stationary Combustion and Purchased Electricity Use by Sector

Sector	Total Energy (mmBtu)	Emissions ($mtCO_2e$)
Buildings & Facilities	118,342	17,893
Streetlights & Traffic Signals	1,675	344
Water Delivery Facilities	20,483	4,208
Wastewater Facilities	36,793	7,004
Solid Waste Facilities	4,135	850
Total	**181,428**	**30,299**

Government Operations Transportation Emissions

The 2007 transportation emissions from mobile fuel combustion by the Frederick County government fleet and transit sectors were 8,737 metric tons of CO_2e, representing 6.33% of total emissions for the government operations inventory. These emissions were calculated from actual fuel consumption and vehicle miles traveled data in accordance with the recommended methodology of the LGOP. Each of the 780 on-road and 80 off-road vehicles for both the county fleet and transit operations were reported by make, model year, vehicle type and fuel type, as well as annual fuel consumption, cost, and vehicle miles traveled for 2007.

From this data, the actual fuel efficiencies were calculated and averaged by classes of vehicles for each fuel type. The annual miles traveled were summed for each vehicle type/model year/fuel type and entered using the average fuel efficiencies. In addition, the fuel costs were summed and entered as well. Certain records were excluded if they did not meet the definition of operational control (e.g. non-profit agencies that were billed for their fuel use) and/or appeared to have obvious errors in data entry. Table 14 summarizes fuel consumption and miles traveled after the data adjustments:

Table 14: 2007 Mobile Combustion Emissions by Sector and Fuel Type with Percent of Total

Sector and Fuel Type	Fuel Consumed (gal)	Emissions ($mtCO_2e$)	Percent of Total
Fleet			
Gasoline	424,955	3,774	43.2%
Diesel	267,642	2,718	31.1%
Total	**692,597**	**6,492**	**74.3%**
Transit			
Gasoline	9,834	87	1.0%
Diesel	212,552	2,158	24.7%
Total	**222,386**	**2,245**	**25.7%**
Combined Total	**914,983**	**8,737**	**100%**

County Landfill and Wastewater Treatment Process Emissions

The 2007 emissions from the solid waste and wastewater data in this report should not be interpreted as presenting precise mass balance calculations of these facilities' emissions or be considered highly accurate. The methodology that was used to calculate emissions from these certain types of activities may not accurately estimate the actual emissions from these activities or may neglect to capture all of the related activity emissions from a particular category.

The emissions data attributable to the historic waste at the two county landfills at Reich's Ford Road were provided by the DUSWM and were calculated by that division outside of the CACP software. The gas emissions were then converted to metric tons and reported as CO_2 equivalents, as is consistent with the methodology of this report.

For wastewater treatment processes, and based on available data, N_2O emissions are included based on data provided by DUSWM; methane emissions attributable to wastewater treatment are not. Using the total Nitrogen (N) contributions in kg/day together with the population served at each facility, as provided by DUSWM, using recommended equations in the LGOP as follows:

Process N_2O Emissions from WWTP with Nitrification/Denitrification:
$Pop_{facility}$ x 7 [emission factor - g N_2O/person/year] x 10^{-6} [conversion from g to metric tons]

Process N_2O Emissions from Effluent Discharge (site specific N load data)*:*
$Pop_{facility}$ x N load x .005 [emission factor] x 365.25 [conversion factor day/year] x 10^{-3} [conversion from kg to metric ton]

The N_2O figures were aggregated and entered into CACP by facility. The LGOP uses standard emissions factors in calculating N_2O emissions associated with wastewater treatment processes following methodology and assumptions found in Section 8.2 of the U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2008). The U.S. EPA inventory report stipulates that estimations using these emission factors have a high uncertainty. More accurate calculation of N_2O emissions from any wastewater treatment process requires other data, including influent nitrogen concentration and the nitrogen concentration in the treatment facilities sludge, as well as the treatment process utilized by each facility. Although the DUSWM provided the more accurate emissions data for incorporation into the report when available, this was not always possible for all types of emissions.

The emissions from these DUSWM processes are summarized below in Table 15 and account for 64.3% of reported Government Operations emissions.

Table 15: 2007 Fugitive Process Emissions for Landfill and Wastewater Treatment

Process	GHG (tons/yr)	Emissions ($mtCO_2e$)
County Landfill		
Methane (CH_4)	3,369	64,182
Carbon Dioxide (CO_2)	24,617	22,332
Wastewater Treatment		
Nitrous Oxide (N_2O)	.907	255

Possible greenhouse gas emissions and offsets associated with the County's natural wood waste composting operation are not included in this report. Quantifying the various greenhouse gas emissions including N_2O, CH_4, certain volatile organic compounds, and sinks from centralized composting operations can be difficult without actual site specific data.

Employee Commute

The emissions attributable to the work commute of Frederick County government employees for 2007 were 8,861 metric tons of CO_2e, representing 6.6% of the County government's total emissions. In April of 2010, the Office of Sustainability & Environmental Resources conducted a survey of employees to gather information about work commute habits and vehicle characteristics. The survey announcement was distributed via the "all county email list", and contained a direct link to a Survey Monkey web page that housed the employee commute survey. The survey commenced on April 16, 2010 and concluded on April 28, 2010. The total number of responses was 800, representing about 25% of the total Frederick County 2010 employee base, including full time, part time and temporary/seasonal employees. From the response data the average fuel efficiency and commute distance were determined as follows:

- Number of Respondents: 800
- Average One Way Distance of Work Commute: 18.6 miles
- Average Miles per Gallon for Respondent Vehicles: 23.53

Employee statistics for the 2010 survey year and the 2007 inventory year were then compared.

Table 16: 2010 and 2007 FCG Employment Statistics

Employment Category	2010 Survey Year	2007 Baseline Year	Percent Change 2007 to 2010
Full Time	2,310	2,324	-.6%
Part Time > 50%	134	129	3.88%
Part Time < 50% & Temporary	668	741	-9.85%
TOTAL	3,112	3,194	-2.57%

For purposes of the emissions' calculation, an assumed average number of workdays per week for each employment category were applied. It was estimated that after conservatively adjusting for vacation, holidays and sick leave, that there are about 230 workdays per year for full time employees.

Table 17: Average Number of Work Days per Employment Category for FCG Employees

Employment Category	Average Number of Work Days per Week
Full Time	5
Part Time > 50%	3
Part Time < 50% & Temporary	2

The 2007 aggregated employee vehicle miles traveled were then calculated for each category using the following equation:

Annual VMT = # of employees x (avg. distance x 2) x (230 x # of workdays/5)

The corresponding amount of fuel in gallons was then calculated as follows:

Annual Fuel Consumption in Gallons = Annual VMT/23.53

This data is summarized in Table 18 below:

Table 18: 2007 FCG Employee Commute VMT and Fuel by Employment Category

Employment Category	Annual VMT (miles)	Fuel (gallons)
Full Time	19,884,144	845,054.99
Part Time > 50%	662,234.4	28,144.26
Part Time < 50% & Temporary	2,535,998.4	107,777.24
TOTAL	**23,082,376.8**	**980,976.49**

Government Operations Emissions Summary

To summarize, the total emissions in 2007 attributable to government operations were 134,667 metric tons of CO_2e, which represents about 2.1% of Frederick County's total emissions. This is below the regional average of 3-4% as estimated by MWCOG in their 2008 climate change report. Since 2007, Frederick County Government has taken significant steps to reduce its carbon footprint through reduction of non-renewable energy consumption. A landfill gas to energy project, fuel conservation plan, and energy conservation initiatives in office buildings are examples of efforts in place. It is anticipated that a 2010 inventory of GHG emissions for FCG would produce sizable reductions from the baseline year.

Recommended Inventory Improvements

Establishing an annual review process for the GHG Inventory with reports delivered to the Frederick County Sustainability Commission and Board of County Commissioners is recommended. The OES has developed an inventory maintenance system for Frederick County to ensure an efficient, organized process moving forward. As noted above, a 2010 inventory would allow for the accounting of sustainability initiatives enacted by the Board of County Commissioners.

A community-wide GHG inventory protocol similar to the LGOP is currently in development by ICLEI-Local Governments for Sustainability and its partners. The new Protocol will provide technical assistance to address emissions that occur from sectors not represented in this inventory including agriculture, land use, forestry and others. In addition, the protocol will include guidance for estimating life cycle emissions for goods and services. This will allow a more comprehensive and complete reporting of all of the County's emissions.

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Potential GHG Reduction Strategies

The *Sustainable Action Plan for County Operations* presented to the Board in August 2010 recommends that FCG commit to a 25% GHG emissions reduction target for County operations by 2025 and develop a plan to meet the reduction target.

Conclusion

This report provides an initial understanding of current GHG emissions and serves as a basis for analyzing and designing mitigation plans and strategies. Reducing emissions is central to improving the quality of life in Frederick County. Through efforts to protect our climate, co-benefits emerge such as increased energy independence and financial savings; reduction in vehicle miles traveled; and improved conditions for human health. Prior to conducting this inventory of greenhouse gases, the County based much of its sustainability decision-making on reducing energy consumption. The OSER anticipates that the baseline data provided here will serve as a tool for designing programs, setting goals, and measuring progress with respect to GHG emissions reductions over time.

Appendix A: Unit Conversions and Equivalencies

Mass & Volume

1 kg = 2.204.6 lb

1 ton (short) = 2,000 lbs. = .9071847 metric tons (mt)

1 metric ton (mt) = 1,000 kg = 2,204.62 lb

1 barrel = 42 gallons

1 cubic foot (ft^3) = 7.482 gallons

Energy

1 kWh = 3,412 Btu

1 mBtu = 1,000 Btu

1mmBtu = 1,000,000 BTU or 1,000 mBtu

1 MWh = 1,000 kWh

1 MWh = 3.412 mmBtu

1 therm = 100,000 Btu

1 gallon gasoline = 124,238 Btu

1 gallon diesel fuel & heating oil = 138,690 Btu

Molecular weight conversion for carbon = 44/12 or 3.667 ton CO_2 emissions per ton C emissions

Appendix B: Community Energy Use Assumptions and Methodology

Residential

- Direct Fuel Use
  - Natural gas: Data for 25,600 customers with a total consumption of 18,635,690.4 therms was provided by Frederick Gas, a division of Washington Gas, and entered.
  - Fuel Oil/Kerosene: Data for 12,450 households identified in the Energy Information Administration's database and using an average household consumption for the South Atlantic census region/Climate Zone 3 (based on heating/cooling days), of which Frederick County is a part, was summed and entered.
  - Liquid Propane Gas (LPG): Data for 3,229 households identified and quantified using the same principles and sources as for fuel oil/kerosene was summed and entered.
- Indirect Fuel Use
  - Electricity: Data for 83,591 customer accounts with a total consumption of 1,413,747,918 kilowatt hours was provided by Allegheny Power (Potomac Edison) and entered.

Non-residential

The data records for the non-residential sector were contained in the same reports as those described in the residential sector. Because of the differences in grouping of sectors between Washington Gas and Allegheny Power, all commercial, industrial, and lighting records were combined into the sector "non-residential". Frederick Gas estimates 2950 non-residential customers for 2007.

- Direct Fuel Use
  - Natural gas: Data for 2,950 customers with a total consumption of 25,235,785.9 therms was provided by Frederick Gas, a division of Washington Gas, and entered.
- Indirect Fuel Use
  - Electricity: Data for 12,440 customer accounts with a total consumption of 1,698,647,311 kilowatt hours was provided by Allegheny Power (Potomac Edison) and entered.